1,170,644

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,170,644

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COMPLETE SPECIFICATION

Improvements in or relating to Electromechanical Shaping of Workpieces

We, VUMA, VYSKUMNY ÚSTAV MECHANIZÁCIE A AUTOMATIZÁCIE, a Czechoslovak Corporation of Nové Mesto nad Váhom, Czechoslovakia, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method of positioning a tool electrode from a workpiece especially for electrochemical polishing or broaching of long openings in a metal body and an apparatus to perform this method.

Electrochemical methods of working metal enable workpieces to be given shapes such as cannot be obtained by machining, or can be made only at extraordinarily high costs and require a single-purpose equipment.

The electrochemical method of working is in principle performed so that the working tool, an electrode, is maintained near the workpiece surface to be worked, whereby through a gap between the surface to be worked and the surface of the electrode there flows an electrolyte so as to flood the entire operating space, i.e. that portion of the gap wherein there is temporarily the surface to be worked and an operating portion of the electrode. The workpiece and the electrode must, however, consist of an electroconducting material, which is chemically inert in respect to the electrolyte. With the electrode and workpiece both connected to a D.C. source, so that the electrode forms a cathode and the workpiece an anode, then at a suitable voltage, electric current passes through the electrolyte and causes electrochemical changes and consequent chemical changes both on the workpiece and the electrode. Due to these changes the material of the surface to be worked is anodically dissolved in consequence of which the resulting substances create, together with hydrogen forming on the electrode, reaction products of the electrochemical process. The reaction products are then carried away from the working space by the flowing electrolyte. The rate of electrochemical dissolving of the workpiece material, i.e. the rate of working, depends on the amount of electric current passing through the electrolyte.

Up to the present, this method enabled only short holes (openings) to be worked in workpieces. The working tool, the electrode, is attached to a device for displacing the electrode longitudinally by means of a rod which controls the position of the electrode, advancing it and guiding it. In the case of long holes of small diameter, however, the rod cannot be rigid enough in the direction at right angles to the direction of displacement, to accurately secure the position of the tool. This results in inaccurately shaped openings and frequently in damaged tools.

The disadvantages disclosed above are overcome by the method for positioning a tool electrode relative to a workpiece according to the present invention.

According to a first aspect of the invention, in a method of electrochemically working the surface defining a bore in a metal body, an electrode is passed through the bore in spaced relation with the surface and the space between the electrode and the surface is filled with an electrolyte which conveys electric current between the metal body and the electrode and wherein the electrode is positioned in correct spaced relation with the surface either by means of at least one electrically insulating projection on the electrode which engages with the surface defining the bore or by passing the electrolyte through the bore at a rate which maintains the electrode in its correct position.

Apparatus for carrying out this method comprises a pair of chambers adapted to be secured one at each end of the bore in the metal body, means for passing an electrolyte from one chamber along the bore to the other chamber, an electrode and means for drawing

the electrode through the bore in spaced relation with the wall defining the bore and wherein the electrode either has at least one electrically insulating projection which engages with the surface to position the electrode or is shaped so as to be correctly positioned in the bore by the flow of electrolyte therethrough.

It is an advantage of the method according to the invention that is possible to work such openings which have the same cross section throughout the full length, the axis of which being not a straight line, but, for instance, part of a curve. Another advantage resides in the fact that deformations are avoided and it is also possible to work openings, the cross section area of which is considerably smaller than the length of the opening, e.g. a circular opening, whose ratio of diameter and length of the opening is greater than 1 : 20. Still another advantage resides in the fact that the manufacture of the tool, i.e. the electrode, is very simple as to accuracy and is not too laborious.

The invention will now be described, by way of example, with reference to the accompanying drawings, wherein

Figure 1 is an apparatus for performing the method according to the invention;

Figure 2 is a guide for the electrode in the apparatus, constituted by the electrolyte flow.

The apparatus to perform the electrochemical broaching of a bore in a metal workpiece comprises a mechanism 31 for advancing an electrode 22, two spaced apart chambers 34 and a workpiece 20.

The mechanism 31 which effects the displacement of the electrode through the bore in the workpiece contains therein a slide block 30 and a pull rod 27.

The pull rod 27 is constituted so that its surface is insulated e.g. with "Teflon" (Registered Trade Mark). At one of its ends the pull rod is provided with a bare core 28 and at the other end there is attached to the pull rod 27 the electrode 22. The pull rod can also 27 the electrode 22. The pull rod can also be flexible, i.e. it can be constituted, for instance, by a cable. The pull rod 27 serves to transmit displacement forces to the electrode 22. The electrode 22 has at one of its ends, in the direction of movement, at least one guide projection 24 consisting of an electrically non-conducting material, e.g. ebonite. The electrode 22 serves to work the workpiece 20 proper and the guide projection 24 to guide the electrode 22 within the workpiece 20 at a suitable distance from the surface 21 to be worked. The hollow chambers 34 are adapted to be secured to the ends of the workpiece 20. The chamber 34 which is nearer to the mechanism 31, has in its end face a hole 26 and in its lateral side an inlet port 37. The chamber 34 which is positioned farther from the mechanism is provided, on its lateral side, with an outlet port 35.

Within the housing of the mechanism 31 is located a slide block 30 movable in the direction "S" and to which is pivotally connected by means of a joint 29, the pull rod 27 which passes through the hole 26 of chamber 34. The pull rod 27 is sealed in the hole 26 by means of a seal 25. The chambers 34 are interconnected through the bore of the workpiece 20, and onto the workpiece is slid a current supply ring 23, connected to a positive pole of an electric current source 32.

To the inlet port 37 of the chamber 34 positioned nearer to the mechanism 31, is attached an inlet conduit 40 for the electrolyte 41, the other end of the conduit is connected to reservoir (not shown) of electrolyte. The inlet conduit 40 is provided with a shut-off device 38, constituted e.g. by a valve. To the outlet port 35 is attached an outlet conduit 39, which is located with its other end in the reservoir of electrolyte. In the outlet conduit 39 is inserted a throttling and shut-off device 36.

The preparation of the apparatus for executing the electrochemical broaching of the opening therein is effected so that the pull rod 27 is positioned in the opening and at one of the ends of the rod 27 is connected the slide block 30. The active portion of the electrode 22, which is beyond the opening of the workpiece 20, is pushed into the other end of the workpiece 20, wherein there is a short surface previously worked. The depth of this previously worked surface of the workpiece 20 has to ensure catching of the guide projection 24 of the electrode 22 and thereby to ensure a gap of at least 0.01 mm between the surface to be worked 21 of workpiece 20 and the guide projection 24. To the workpiece 20 are then attached the chambers 34 to which, in turn, are connected the inlet conduit 40 and the outlet conduit 39, the apparatus being thus ready to allow the electrolyte 41 to flow through. Once this operation of preparing is concluded, the electrolyte 41 begins to flow through inlet conduit 40 to the workpiece 20 along the bore in the workpiece and along the active portion of the electrode 22, through the more distant chamber 34 and outlet conduit 39 to the reservoir (not shown) of electrolyte. The inlet pressure of electrolyte 41 (e.g. kitchen salt solution) should attain 2 to 20 atmosphere. Upon connecting the electric current source 32, an electrolysis between the electrode 22 and the surface 21 to be worked of workpiece 20 takes place and the result is electrochemical dissolving of the metal of workpiece 20; whereby by displacing the electrode 22 along the opening a worked surface is formed on the workpiece 20, its shape being similar to the cross section shape of the electrode 22, nearer to the chamber 34, wherein the outlet port 35 is provided. The individual cross section along the electrode 22 need not be similar in geometrical shape, but it is necessary that the cross section nearest to the chamber 34 comprising the inlet port 37, which should be geometri-

cally similar to the original opening within the workpiece 20, continually merges into the cross section similar in geometrical shape, which is obtained by electrochemical broaching of the opening of workpiece 20. In this manner it is possible to enlarge not only circular openings, but also to form a rectangular opening from a circular one.

With this sense of flow of electrolyte 41, which is advantageous for electrochemical broaching of long bars having a very small opening, an advantageous distribution of pressure drop of electrolyte 41 during its flow through the apparatus takes place and a uniform flow of the electrolyte 41 aong the electrode 22 can be ensured. For the electrochemical broaching of the long bars having very small openings, no opposite sense of flow of electrolyte 41 can be employed, i.e. from the chamber 34 which is more distant from the control mechanism 31, to the chamber 34 nearer thereto, since an essential pressure drop occurs when passing through the space between the electrode 22 and the adjacent surface 21, the resulting pressure loss being so considerable that the remaining pressure of the electrolyte 41 is insufficient to ensure the necessary volume amount of electrolyte 41 to flow through the opening of the workpiece 20 along the pull rod 27. The size of the pull rod 27 cannot be arbitrary decreased, because together with the decreasing of the cross section of the core 28 of the pull rod 27, the utilisable intensity of the electric current flowing through the core 28 is simultaneously decreased and effects the electrochemical working of surface 21. If this method would be applied to the broaching of not too small openings of long bars with a moderate feed rate of the electrode 22, which makes it possible to use a larger diameter of the cross section of core 28 of the pull rod 27, the electrolyte 41 can flow in a sense corresponding to the sense of feed of the electrode, i.e. in the apparatus according to Figure 1, the electsolyte would be flowing from the chamber 34, which is more distant from the control mechanism 31 to the chamber 34, which is nearer thereto.

Fig. 3 shows another electrochemical broaching arrangement: The electrode is not fitted with any electrically non-conducting projection designed to space the electrode from the surface 21. The core of the pull rod 27 is flexible (for instance a cable) in order to increase the flexibility of the electrode at right angles to the direction of displacement through the bore. The flowing electrolyte 41 itself is used, in this case, for positioning the electrode from the surface 21 being worked. This electrode which is positioned by the electrolyte flowing around its periphery renders it even possible to broach openings the axis of which is curved. An electrically non-conductive spacing cylinder 33 is provided in front of the electrode 22 from the side of the electrolyte inlet in order to prevent short circuiting if the pressure of the electrolyte 41 drops allowing the electrode 22 to drop into engagement with one side of the workpiece 20. In such a case the workpiece 20 comes to bear against the electrically non-conducting spacing cylinder 33. During the apparatus connected to the current source 32 and the electrolyte flowing (in the direction indicated), the electrode 22 is hovering (floating) in the electrolyte flow and the electrochemical process of broaching is running.

During the flow of the electrolyte the electrode 22 oscillates at right angles to the feed motion thus getting alternatingly nearer to and further from the surface 21 to be worked of workpiece 20. At extreme oscillation amplitudes the electrode 22 works the inner surface of the workpiece 20 with small interelectrode gaps which, together with the oscillations of the electrode 22, allow to work with an increased accuracy. The oscillating character of the electrode 22 is not determined by the flow character of the electrolyte 41.

WHAT WE CLAIM IS:—

1. A method of electrochemically working the surface defining a bore in a metal body in which an electrode is passed through the bore in spaced relation with the surface and the space between the electrode and the surface is filled with an electrolyte which conveys electric current between the metal body and the electrode and wherein the electrode is positioned in correct spaced relation with the surface either by means of at least one electrically insulating projection on the electrode which engages with the surface defining the bore or by passing the electrolyte through the bore at a rate which maintains the electrode in its correct position.

2. Apparatus for carrying out the method claimed in claim 1 comprising a pair of chambers adapted to be secured one at each end of the bore in the metal body, means for passing an electrolyte from one chamber along the bore to the other chamber, an electrode and means for drawing the electrode through the bore in spaced relation with the wall defining the bore and wherein the electrode either has at least one electrically insulating projection which engages with the surface to position the electrode or is shaped so as to be correctly positioned in the bore by the flow of electrolyte there through.

3. A method as claimed in claim 1 substantially as described with reference to the accompanying drawings.

4. An apparatus as claimed in claim 2, substantially as described with reference to the accompanying drawings.

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1170644 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

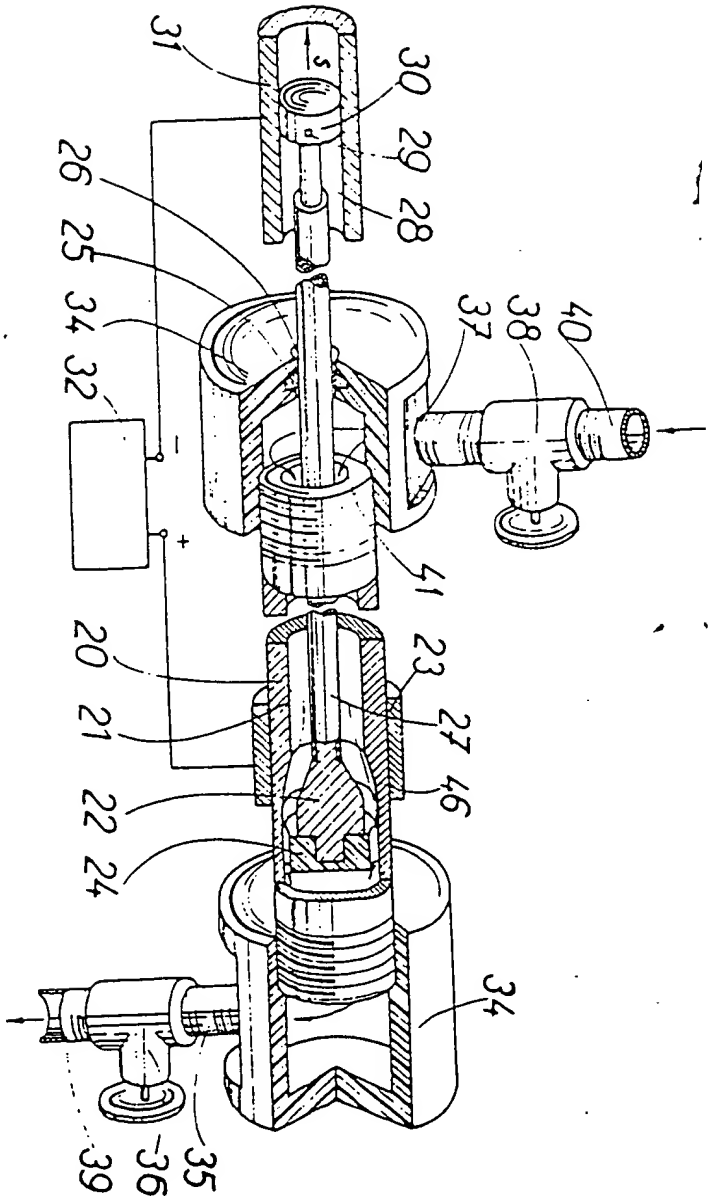

Fig. 1

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

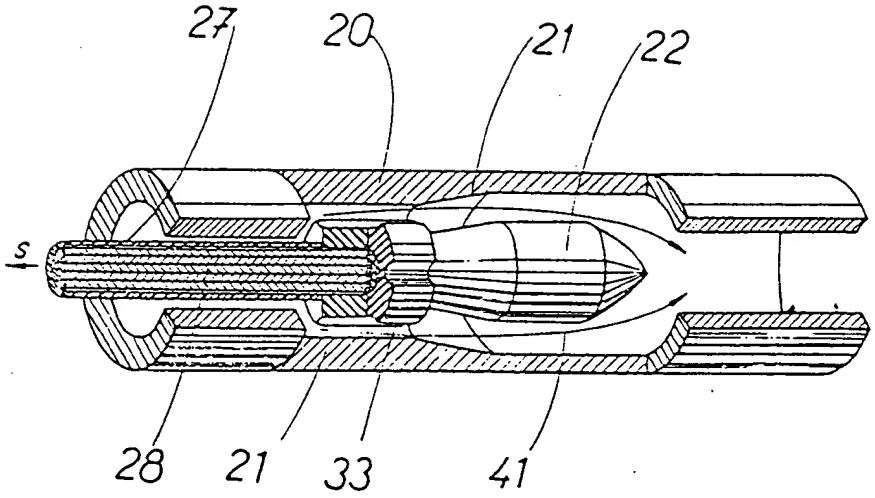

Fig. 2